Qazvin University of Medical Science
Department of Immunology & Microbiology

Biological,Chemical & Physical Hazards in Laboratory

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Hazard Assessment Process

- Laboratory workers may be exposed to a variety of workplace hazards in the course of performing their functions.
- The type and degree of exposure is dependent upon the type of laboratory and its location.
- A key component of a health and safety program is to identify and assess hazards and determine appropriate controls

Systematic approach to hazard assessment

I. List all work-related tasks and activities.

II. Identify potential **biological, chemical, physical** hazards associated with each task.

III. Assess the risk of the hazard by considering the severity of consequences of exposure, the probability that the exposure will occur and the frequency the task is done.

IV. Identify the controls that will eliminate or reduce the risk. The hierarchy of controls should be followed. This means that **engineering controls** are the most effective, followed by **administrative controls** (such as training and rules), followed by **personal protective equipment (PPE)**.

V. Implement the controls for each hazard.

VI. Communicate the hazard assessments and required controls to all workers who perform the tasks.

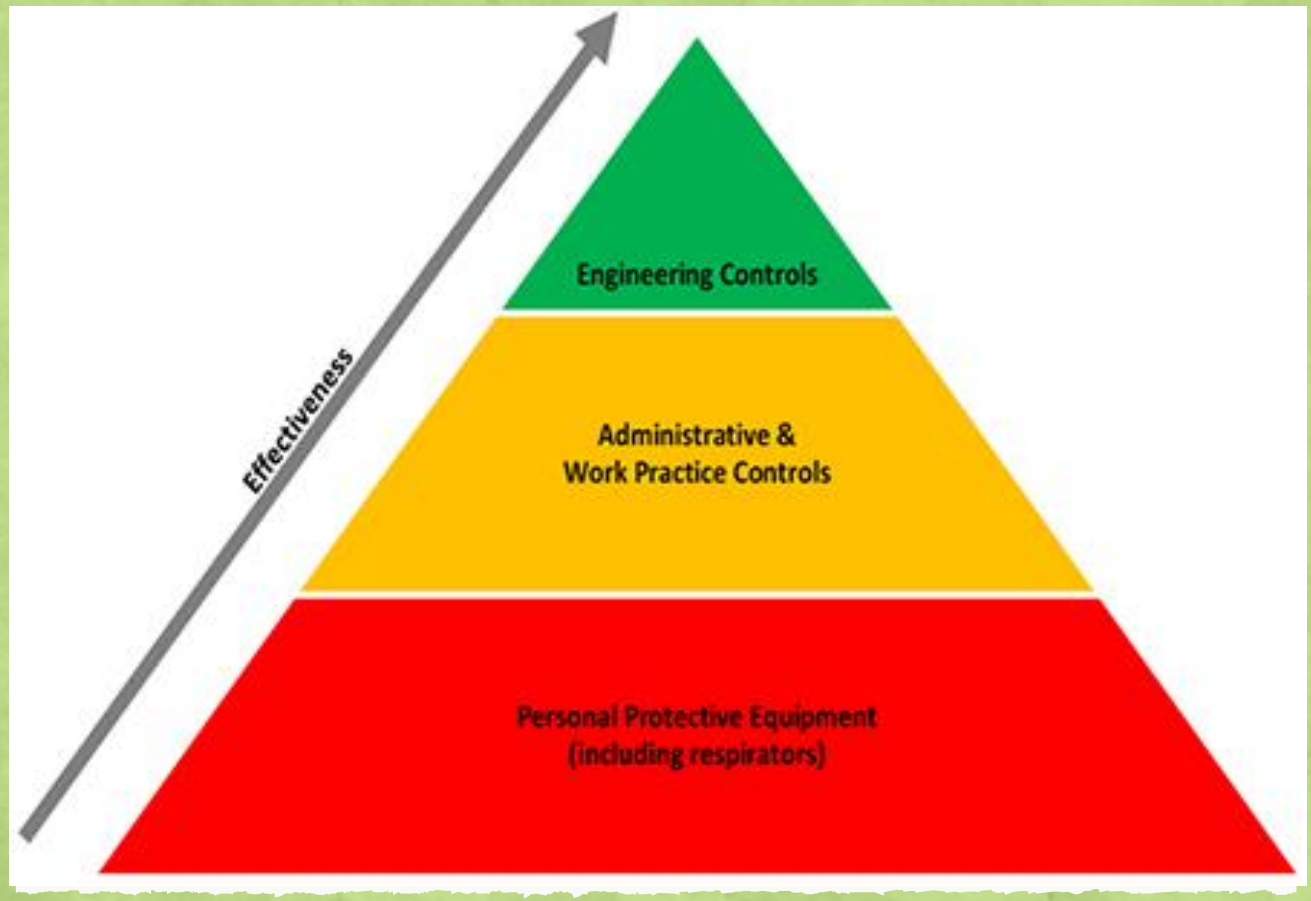
VII. Evaluate the controls periodically to ensure they are effective.

Biological Hazards

- **Biological hazards**, also known as biohazards, refer to biological substances that pose a threat to the health of living organisms, primarily that of humans.
- This can include medical waste or samples of a microorganism, virus or toxin (from a biological source) that can affect human health.

What are the Controls?

- Engineering Controls
- Administrative Controls
- Personal Protectiv Equipment (PPE)



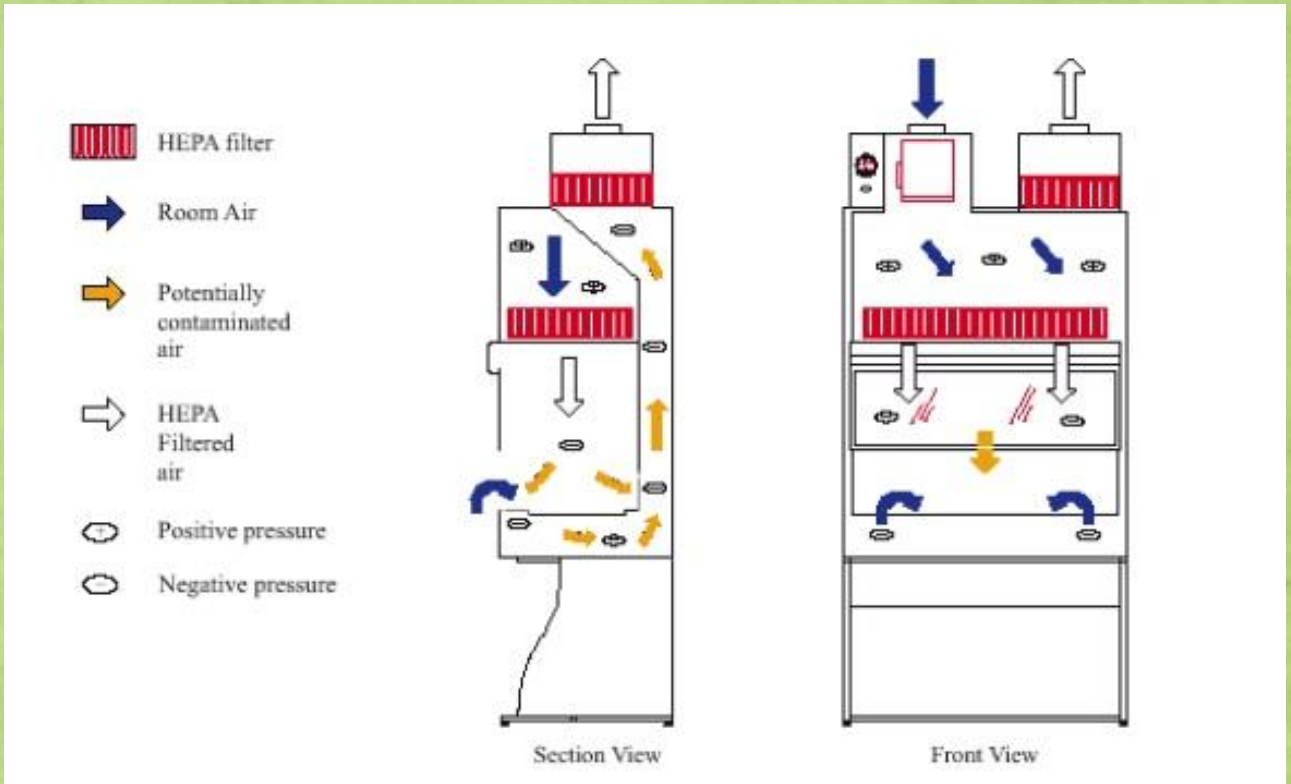
Engineering Controls

✓ **<u>In the hierarchy of controls, the highest level of control is directed at the source.</u>**

Typically, for patient related infectious disease, this means isolation of the patient and precautions related to handling blood and body fluids of the patient, as well as biological waste handling procedures.

Good engineering controls such as :

- Vaccines
- Proper ventilation
- Needleless systems
- Safety engineered sharps
- Biological safety cabinets
- Effective biological waste containment



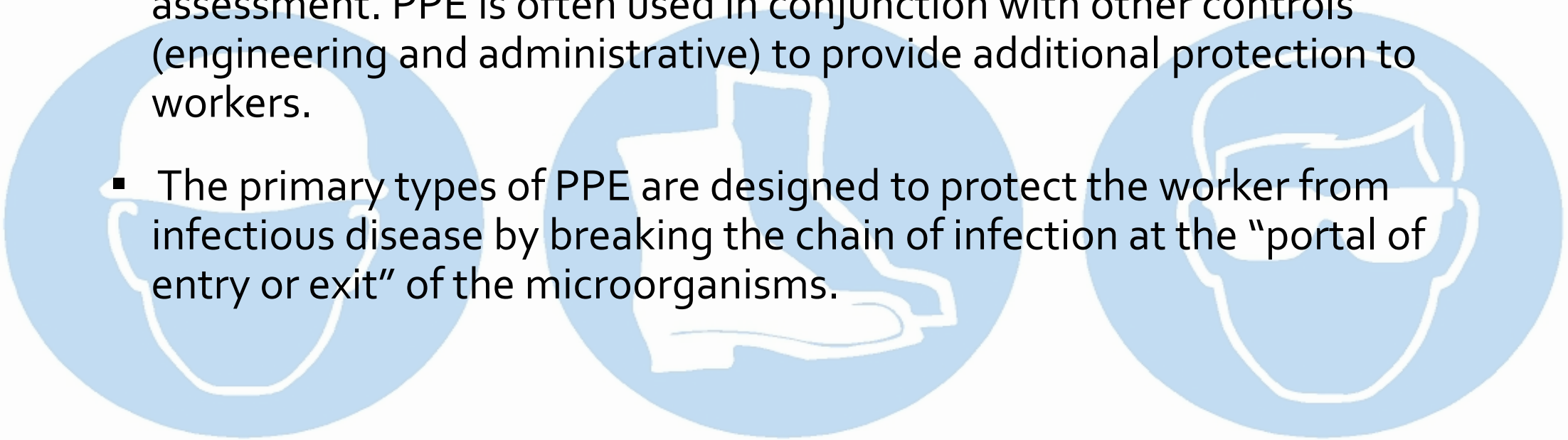
Prefilled Syringes

Administrative Controls

- The next level of controls includes administrative controls. Because it is not always possible to eliminate or control the hazard at the source, administrative controls are frequently used for biological hazards in healthcare.
- Administrative controls focus on ensuring that the appropriate prevention steps are taken, that all proper work procedures are documented, that laboratory staff are trained to use the proper procedures, and that their use is enforced.
- Administrative controls related to the prevention of exposure to **biological hazards** include the :
- development of infection prevention and control guidelines, including equipment decontamination and safe work procedures for building maintenance and protocols for construction and renovation projects.

P.P.E. REQUIRED

- Personal protective equipment such as **gloves**, **respiratory protection** and **eye protection** should be used based on the risk assessment. PPE is often used in conjunction with other controls (engineering and administrative) to provide additional protection to workers.
- The primary types of PPE are designed to protect the worker from infectious disease by breaking the chain of infection at the "portal of entry or exit" of the microorganisms.



Potential Biological Hazards	Summary of Major Control Strategies		
	Engineering	Administrative	PPE
Exposure to bloodborne pathogens through needle stick, glass slides, tubes, pipettes or other sharps injuries	Engineered needle stick prevention devices. Elimination of use of any unnecessary sharps. Avoid using glass products whenever possible. Availability of sharps containers for disposal. Vaccines.	Compliance with all infection prevention and control practices. Immunization program. Worker education.	Gloves, protective clothing, eye and face protection.
Exposure to bloodborne pathogens through contaminated items and surfaces, exposure to mucous membranes	Vaccines.	Compliance with all infection prevention and control practices. Immunization program. Worker education.	Gloves, protective clothing, eye and face protection.
Exposure to airborne biological agents through contact with secretions from infectious patients	Early detection of infection status. Isolation.	Compliance with all infection prevention and control practices. Immunization program. Worker	PPE based on the risk assessment may include gloves, respiratory

(coughing, sneezing, etc.) or air contaminated with infectious biological agents		education.	protection, eye and face protection and other protective clothing.
Exposure to droplets containing infectious biological agents through contact with patient secretions or contaminated environmental surfaces or equipment	Use of biosafety cabinets for handling patient samples. Early detection of infection status.	Good housekeeping practices. Compliance with all infection prevention and control practices. Spill response procedures. Worker education.	PPE based on the risk assessment may include gloves, respiratory protection, eye and face protection and other protective clothing.
Exposure to biological hazards through specimen accessioning and laboratory testing procedures that generate aerosols	Automated systems where possible. Aerosol reduction equipment, including use of centrifuge carriers with lids. Use of biosafety cabinets. Vaccines.	Training in and enforcement of safe work practices. Designation of clean/contaminated areas or equipment. Immunization program.	PPE based on the risk assessment may include protective clothing, gloves, respiratory protection, eye and face protection.
Exposure to concentrated doses of biological agents	Use of biosafety cabinets. Appropriate containment level facilities. Aerosol reduction equipment. Vaccines.	Aerosol reduction procedures. Training in and enforcement of safe work practices. Immunization program. Worker education.	PPE based on the risk assessment may include protective clothing, gloves, respiratory protection, eye and face protection.
Exposure to pathogens present in tissues	Appropriate containment level facilities. Local exhaust ventilation for grossing. Appropriate autopsy room ventilation.	Training in and enforcement of safe work practices.	PPE based on the risk assessment may include protective clothing, gloves, respiratory protection, eye and face protection.
Exposure to environmental biological contaminants from ventilation systems, water or food	Maintenance of ventilation systems. Early spill clean-up. Preventive maintenance of ventilation systems and water supply systems with regular testing to ensure proper functioning. Early detection and remediation of mould.	Infection prevention and control practices related to building maintenance and food preparation. Protocols for construction and renovation projects that reduce contamination. Worker education.	Use of proper PPE when cleaning contaminated environmental surfaces, including gloves, respiratory protection, and eye protection.

Chemical Hazards

- A **chemical hazard** is any substance that can cause harm, primarily to people. Chemicals of all kinds are stored in laboratories and can result in serious injuries if not properly handled.

What are the chemicals?

- Alcohol handsanitizers
- Detergents
- Low Level Disinfectants
- Formaldehyde
- Glutaraldehyde
- Hydrogen Peroxide
- Ortho-phthalaldehyde(OPA)
- Acids/bases
- Alcohols
- Organic solvents
- Toxic chemicals (ethidium bromide)
- Other chemical waste
- Compressed gases
- Mercury

Chemical Hazard Controls

Engineering Controls

- Elimination
- Substitution
- Local exhaust ventilation
- General ventilation (only appropriate for non-toxic chemicals)
- Isolation/enclosed processes
- Proper chemical storage
- Facility design

Administrative Controls

- Having an effective WHMIS Program
- Monitoring the environment for chemical hazards
- Work scheduling
- Purchasing practices
- Health surveillance and medical monitoring; follow-up procedures for exposed workers
- Safe work procedures including spill response, chemical waste handling and disposal
- Training

Personal Protective Equipment (PPE)

- Gloves
- Gowns
- Eye protection
- Respirators

What is the Globally Harmonized System (GHS)?

GHS stands for the Globally Harmonized System of Classification and Labelling of Chemicals. GHS is a system that defines and classifies the hazards of chemical products, and communicates health and safety information on labels and safety data sheets). The goal is that the same set of rules for classifying hazards, and the same format and content for labels and safety data sheets (SDS) will be adopted and used around the world. An international team of hazard communication experts developed GHS.

What is WHMIS?

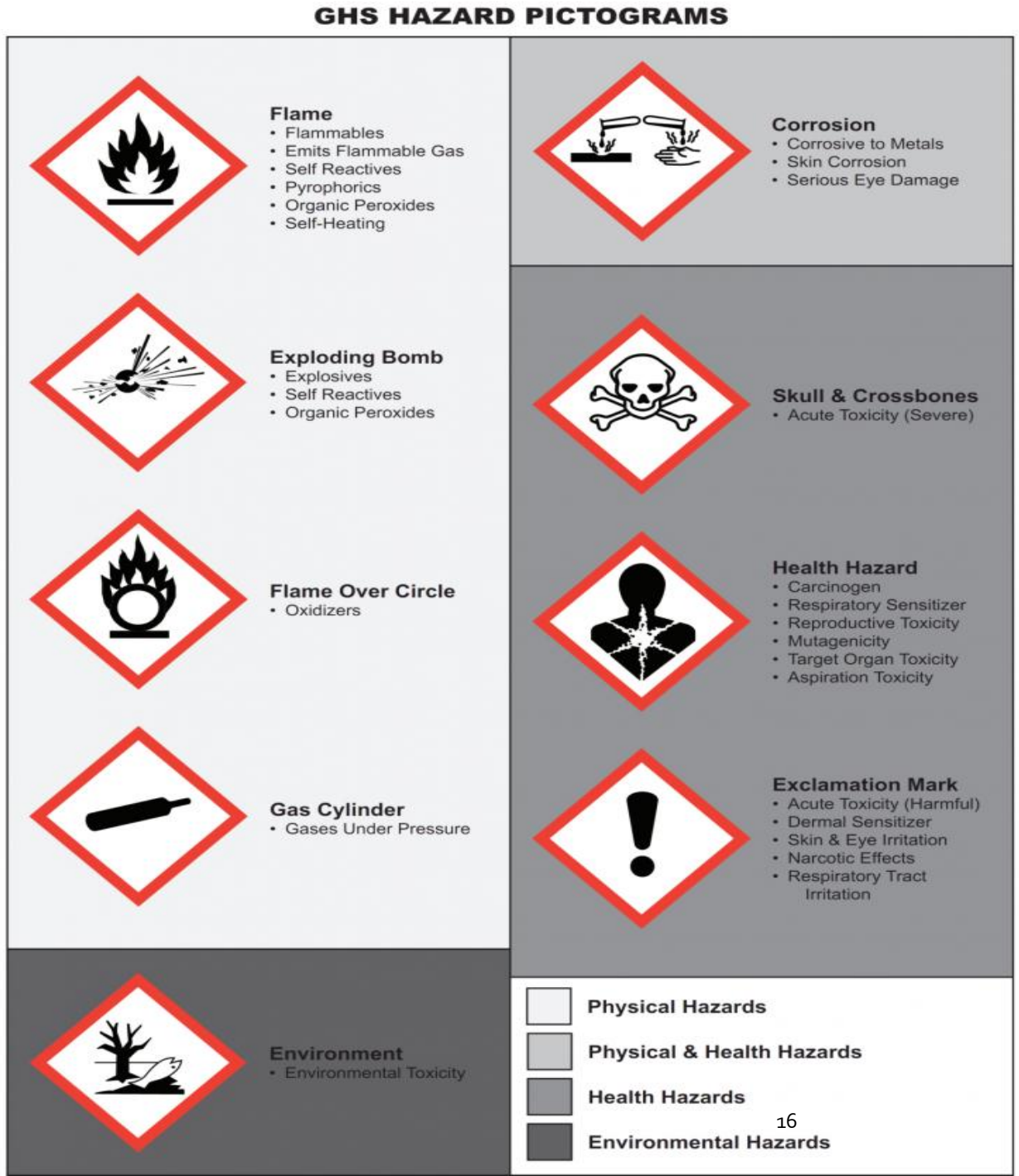
WHMIS is a short form for Workplace Hazardous Materials Information System. It is a comprehensive plan for providing information on the safe use of hazardous materials used in Canadian workplaces. Information is provided by means of product labels, material safety data sheets (MSDS) and worker education programs.

- **Hazard group**

GHS divides hazards into three major groups **health**, **physical** and **environmental**.

- **Class**

Class is the term used to describe the different types of hazards. For example, **Gases under Pressure** is an example of a class in the physical hazards group.



Categories

Each hazard class contains at least one category.

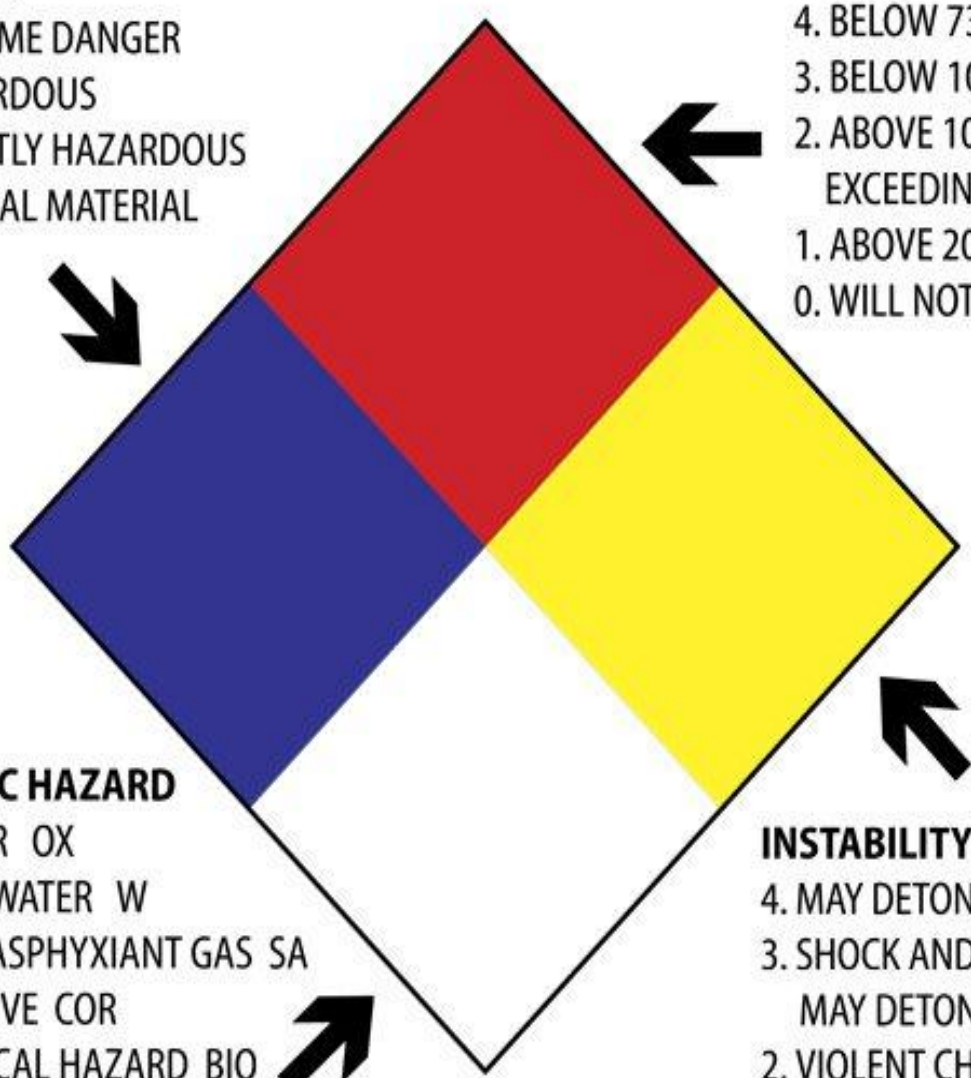
✓ The hazard categories are assigned a number (e.g., 1, 2, etc.)

	Usage
 Health hazard	• Respiratory sensitization, category 1 • Germ cell mutagenicity, categories 1A, 1B, 2 • Carcinogenicity, categories 1A, 1B, 2 • Reproductive toxicity, categories 1A, 1B, 2 • Specific target organ toxicity following single exposure, categories 1, 2 • Specific target organ toxicity following repeated exposure, categories 1, 2 • Aspiration hazard, categories 1, 2

Chemical (category or group)	Common Uses and Examples	Exposure and Health Effects Information	Controls
Detergents	Cleaning a variety of surfaces	Possible eye, skin, and respiratory irritants. Some products may cause allergic dermatitis or contain sensitizers such as nickel or limonene. May react with other products to create hazardous products.	E- Substitution with less harmful product. Properly designed and maintained ventilation systems. Automatic diluting machines. A- Practice to purchase products in ready to use concentrations to minimize handling. Safe work procedures. WHMIS program and maintenance of MSDSs. Worker education. Accommodation for sensitized workers or those with health issues, P- Gloves and eye protection.

HEALTH HAZARD
4. DEADLY
3. EXTREME DANGER
2. HAZARDOUS
1. SLIGHTLY HAZARDOUS
0. NORMAL MATERIAL

FIRE HAZARD
FLASH POINTS
4. BELOW 73° F
3. BELOW 100° F
2. ABOVE 100° F NOT EXCEEDING 200° F
1. ABOVE 200° F
0. WILL NOT BURN



SPECIFIC HAZARD
OXIDIZER OX
USE NO WATER W
SIMPLE ASPHYXIANT GAS SA
CORROSIVE COR
BIOLOGICAL HAZARD BIO
POISONOUS POI
RADIOACTIVE RA
CRYOGENIC CYL

INSTABILITY
4. MAY DETONATE
3. SHOCK AND HEAT MAY DETONATE
2. VIOLENT CHEMICAL CHANGE
1. UNSTABLE IF HEATED
0. STABLE

By : Gelareh Nasiri / Dr.M.Aslanimehr

ScienceLab.com
Chemicals & Laboratory Equipment

Health	2
Fire	3
Reactivity	0
Personal Protection	H

Material Safety Data Sheet
Acetone MSDS

Section 1: Chemical Product and Company Identification

Product Name: Acetone

Catalog Codes: SLA3502, SLA1645, SLA3151, SLA3808

CAS#: 67-64-1

RTECS: AL3150000

TSCA: TSCA 8(b) inventory: Acetone

CI#: Not applicable.

Synonym: 2-propanone; Dimethyl Ketone; Dimethylformaldehyde; Pyroacetic Acid

Chemical Name: Acetone

Chemical Formula: C3-H6-O

Contact Information:

Sciencelab.com, Inc.
14025 Smith Rd.
Houston, Texas 77396

US Sales: **1-800-901-7247**
International Sales: **1-281-441-4400**

Order Online: ScienceLab.com

CHEMTREC (24HR Emergency Telephone), call:
1-800-424-9300

International CHEMTREC, call: 1-703-527-3887

For non-emergency assistance, call: 1-281-441-4400

Section 2: Composition and Information on Ingredients

Composition:

Name	CAS #	% by Weight
Acetone	67-64-1	100

Toxicological Data on Ingredients: Acetone: ORAL (LD50): Acute: 5800 mg/kg [Rat]. 3000 mg/kg [Mouse]. 5340 mg/kg [Rabbit]. VAPOR (LC50): Acute: 50100 mg/m 8 hours [Rat]. 44000 mg/m 4 hours [Mouse].

Section 3: Hazards Identification

Potential Acute Health Effects:
Hazardous in case of skin contact (irritant), of eye contact (irritant), of ingestion, of inhalation. Slightly hazardous in case of skin contact (permeator).

Potential Chronic Health Effects:
CARCINOGENIC EFFECTS: A4 (Not classifiable for human or animal.) by ACGIH.
MUTAGENIC EFFECTS: Not available.
TERATOGENIC EFFECTS: Not available.
DEVELOPMENTAL TOXICITY: Classified Reproductive system/toxin/female, Reproductive system/toxin/male [SUSPECTED].
The substance is toxic to central nervous system (CNS).
The substance may be toxic to kidneys, the reproductive system, liver, skin.
Repeated or prolonged exposure to the substance can produce target organs damage.

Chemical (category or group)	Common Uses and Examples	Exposure and Health Effects Information	Controls
Toxic chemicals, including research laboratory chemicals	Wide variety of chemicals used in laboratories for testing and research – may include stains, fixatives, and other reagents. Geno-reactive/geno-toxic and mutagenic chemicals (e.g. ethidium bromide, osmium tetroxide) are used in some specialized laboratories.	Depending upon the toxicology of specific chemical, exposure can be through any route of entry and affect most human organs. Other effects may include reproductive effects, carcinogenicity, mutagenicity, teratogenicity etc.	E- Elimination where possible. Substitution with less harmful products. Local exhaust ventilation may be required including fume hoods. Enclosed and automated processes. A- Safe work procedures and provide worker education. Safe work procedures and education are critical for safe handling with hazardous materials. Exposure monitoring where applicable. WHMIS program and maintenance of MSDSs. Accommodation for workers with special needs (pregnant workers, persons with sensitivities). P- PPE as required based on hazard assessment. Refer to individual MSDSs.

ETHIDIUM BROMIDE DISPOSAL

ETHIDIUM BROMIDE DISPOSAL

2. Chemical Deactivation

Chemical deactivation is not the preferred disposal method.

✓ Armour Method

This is the simplest method :

- Combine equal amounts of EtBr solution and **household bleach**.
- Stir constantly for four hours or let sit for 2-3 days.
- Adjust pH to 4-9 with **sodium hydroxide.**
- Pour down drain with copious amounts of water.

✓ Lunn & Sansone Method

(For each 100 ml of aqueous EtBr solution)

- Add **5% hypophosphorous acid**.
- Add 12 ml of **0.5 M sodium nitrite**.
- Stir briefly and let stand for 20 hours.
- Adjust **pH to 7-9** using **sodiumhydroxide**.
- Pour down drain with copious amounts of water.

✓ Quillardet and Hoffnung Method

This method uses **0.5 M potassium** permanganate and **2.5 M hydrochloric acid**.
Since chlorine gas may be released in significant concentration, It does not recommended.

ETHIDIUM BROMIDE DISPOSAL

III. Contaminated Labware

- Potentially dangerous **needles, scalpels, pipettes** and **other sharps** contaminated with EtBr.Contaminated sharps must not contain any liquids and should be disposed of directly into an approved sharps container.
- **Disposable glassware** incidentally contaminated with EtBr should be disposed of in a puncture resistant broken glass container and disposed of as non-regulated domestic waste.
- **Centrifuge** and **test tubes** contaminated with EtBr should first be emptied and the liquid disposed of in accordance with the procedures above. Empty incidental tubes can be disposed of as non-hazardous domestic waste.

Chemical (category or group)	Common Uses and Examples	Exposure and Health Effects Information	Controls
Mercury	Metallic mercury may be found in thermometers and pressure gauges	Exposure is through inhalation of vapours, ingestion and skin absorption. Skin sensitizer. Corrosive as liquid. Target effects to the nervous system,	E- Elimination of mercury containing equipment. Substitution with less harmful product. Enclosed mercury sources. Properly designed and maintained ventilation systems. Local exhaust ventilation may be required. A- Safe work procedures including spill
		kidneys, cardiovascular and eyes.	procedures. Education of workers in the nature of the hazard. Purchasing controls to restrict mercury containing materials from entering facility. Monitoring of the work environment following a spill. Good hygiene practices. Appropriate storage of products to decrease exposure. P- Protective clothing, gloves, eye and face protection, and respiratory protection based on hazard assessment.

Physical Hazards

There are a variety of potential physical hazards in medical laboratories :

- **Mechanical hazards** or **electrical hazards** associated with laboratory equipment may be present.
- **Cuts** are common laboratory injuries, often sustained when coming into contact with broken glassware or sharp tools or equipment.
- Exposure to **extremes of temperature** may also produce injury – working for extended periods in cold rooms, working with cryogenic materials, using hot plates, coming into contact with hot surfaces or materials or steam from autoclaves may all pose risks to laboratory workers.
- **Slips, trips and falls** may also occur in laboratories, especially those with slippery floor surfaces.

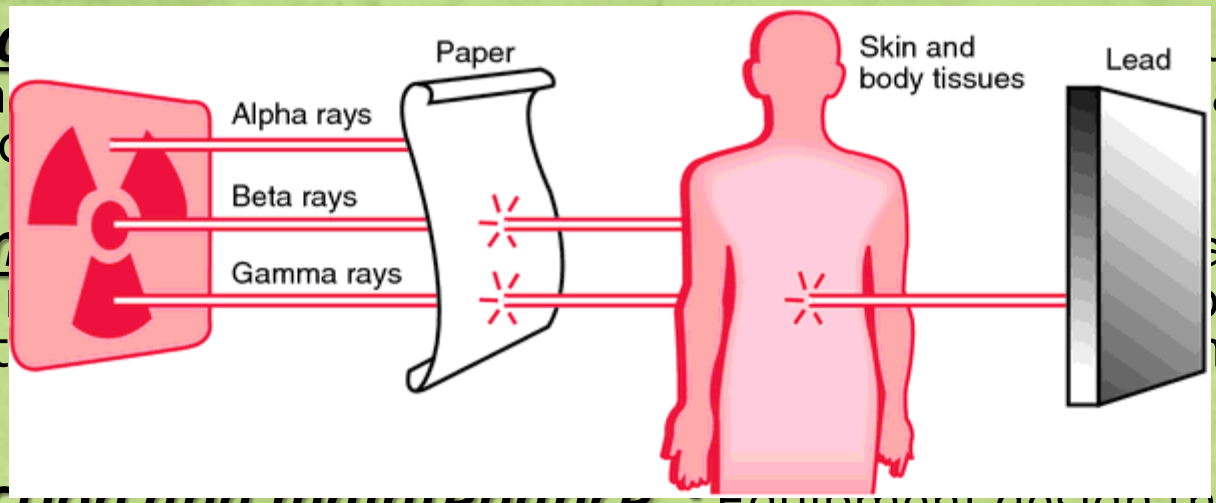
Potential Physical Hazards	Summary of Major Control Strategies		
	Engineering	Administrative	PPE
Exposure to ionizing radiation through the use of radio-isotopes for various assays/procedures	Substitute process with an alternative that does not use radioisotopes (ELIZA, fluorescence, etc.). Use of short-lived isotopes. Use of fume hood. Shielding appropriate to nature of isotope.	Radiation safety program. Worker education. Radiation safety program. Designated Radiation Safety Officer (RSO). Safe work procedures including minimizing time of exposure, proper labeling, etc. Exposure monitoring. Medical monitoring with some isotopes (Iodine). Proper waste disposal.	Gowns, gloves, eye protection.
Exposure to microwave radiation through the use of microwave ovens to heat agar or other reagents	Ensure proper maintenance of equipment (including periodic verification of any leaks). Interlock systems to ensure microwaves not generated when oven doors are open.	Worker education. Safe work procedures that incorporate ensuring the worker uses distance as a control measure	.
Falling hazards associated with slips, trips and falls	Install slip resistant flooring. Design stairwells according to accepted safety standards. Ensure adequate lighting.	Perform regular maintenance on flooring, stairwells, hallways, handrails, etc. Inspect ladders prior to use. Worker education. Implement a spill cleanup program that includes prompt spill cleanup, use of warning signs, etc. Maintain good housekeeping practices and minimize clutter and tripping hazards.	Appropriate footwear with gripping soles and good support.
Cuts from broken glassware, including capillary tubes and specimen vials	Substitute with other materials (plastics). Change procedure to reduce use of capillary tubes. Proper type of glass for use in autoclaves. Use of centrifuge carriers with caps.	Worker education. Safe work procedures including removal of broken items from equipment (autoclaves, centrifuges, etc.), safe disposal of sharps, etc.	Eye protection, protective clothing, and gloves as per hazard assessment.
Cuts from sharp instruments including scalpels, scissors and medical instruments	Avoid use of sharps when not required. Replace sharps with Safety Engineered Medical Devices. Proper storage of sharps.	Worker education. Safe work procedures.	Eye protection, protective clothing, and gloves as per hazard assessment.

Radiation
Engineering Controls

1. Elimination and substitution: For ionizing radiation, elimination is sometimes an option when considering radioimmunoassays in laboratories, which are increasingly replaced by enzyme immunoassays or fluorescent marker procedures.

2. Shielding : It relies on providing a specific barrier material that absorbs, stops or attenuates the radiation. The type of shielding material required is determined by the type of radiation

3. Design considera …used to reduce exposure by providing barriers a… …an greatly reduce awkward movement fo…



4. Interlock system …ation equipment to ensure that the equipment ca… …ock systems include the system that prevents t… …hen the UV lamp is turned on.

5. Equipment selection and maintenance : Equipment design that includes advanced safety features (such as audible/visible signals when the equipment is operating, interlock or key/lock systems, permanent shielding, etc.)

Radiation
Administrative Controls

- Administrative controls include policies and procedures and on-going assessment of possible exposures to radiation. The policies and procedures are designed to ensure that workers are informed about the hazards of radiation and are trained in the safe work procedures necessary to prevent exposure.

1. Inspection and Registration of Radiation Equipment

2. Radiation Safety Program

3. Time

4. Training

5. Safe work procedures

6. Exposure monitoring

7. Disposal procedures

Radiation
Personal Protective Equipment Controls

- Depending upon the nature of the radiation and the specific tasks the worker is performing, a range of PPE may be used as additional controls (to engineering and administrative controls) to reduce exposures.

Examples include:

- **protective eyewear** used when working with lasers, UV, infrared or ionizing radiation that is specifically made to reduce exposure to each type of radiation.
- **Protective clothing** is also used when working with various forms of radiation. For ionizing radiation, protective clothing (commonly called lead aprons) includes shielding materials.
- **Gloves** protect workers from contamination with radioactive material and must be worn when there is the potential for contamination.


Thank you
FOR WORKING SAFELY